TITLE
*ASP Conference Series, Vol. **VOLUME***, **YEAR OF PUBLICATION***
NAMES OF EDITORS

Triggers and alerts with GLAST

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Abstract. We present preliminary results on Gamma Ray Burst (GRB) triggers with the Gamma-ray Large Area Space Telescope (GLAST). After a brief summary of the detector layout, GLAST expected performances on GRB detection are recalled. Status report on the simulation software and preliminary triggers studies are then reported, already showing significant improvement on EGRET results.

1. Description of the instruments

GLAST is a next generation high-energy gamma ray observatory, onboard a satellite scheduled for launch in 2006. It consists of a Large Area Telescope (LAT, see Brez, S. et al. 2001) and a GLAST Burst Monitor (GBM, see Kippen et al. 2001), and is designed for making observations of gamma-ray sources in the 10 keV to 300 GeV energy range.

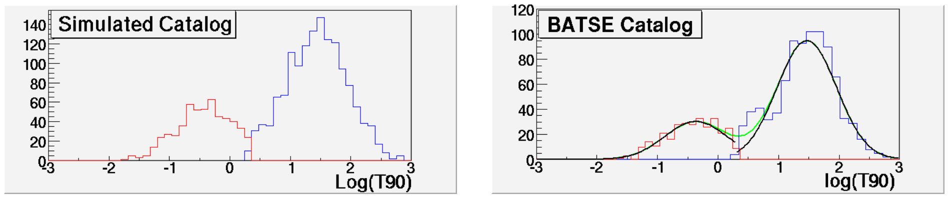

Figure 1. Comparison between the observed (left) and the simulated (right) distribution of GRB duration.

The LAT is a pair conversion telescope, operating from 10 MeV to more than 300 GeV. It is composed of three subsystems: the Anti-Coincidence Detector (ACD) is responsible for vetoing the enormous charged cosmic-ray background and the Earth albedo secondary electrons and nuclei. The tracker (TKR) consists of a four-by-four array of tower modules, each of which being composed of 19 pairs of interleaved planes of silicon strip detectors and tungsten converter sheets. The silicon strip detectors track the electron positron pair created by the incident gamma. The calorimeter (CAL) is a segmented arrangement of CsI(Tl) bars, designed to give both longitudinal and transverse information on the energy deposition pattern.

The tracker will have the ability to determine the location of an object in the sky to within 0.5 to 5 arc minutes. The pair conversion signature is also used to help reject the background of charged cosmic rays. The GBM provides overlapping energy coverage in the range 10 keV to 25 MeV for bright transients such as bursts and solar flares. It is composed of 4 triplets of NaI(Tl) scintillators(low energy band) and 2 BGO scintillators (high energy band).

Due to its angular resolution (5 times better than EGRET) and its improved afterglow sensitivity, GLAST will extend the knowledge about GRB's. Its large field of view (about 2 sr) and its improved effective area (10 times EGRET's) will provide better burst statistics (up to 100 bursts/year with many more photons detected.)

The GBM will enhance GRB science with GLAST by providing low energy context measurements with high time resolution. This will improve GLAST's wide band spectral sensitivity, allow for comparison of low energy versus high energy temporal variability, and provide a continuity with current GRB knowledge base (e.g GRO-BATSE.) Moreover, the GBM provides fast time/location triggers: within 2 seconds, it will provide approximate locations for ground or space follow up observations. In case of specifically interesting events, it will allow, within ten minutes, for repointing of GLAST for afterglow observations.

2. GLAST and GRB Simulations

The LAT team has set up a complete simulation chain, including generation of the incoming flux, full simulation of the detector resonse, reconstruction chain and analysis of the final trigger and alert. It is to be noted that the flux simulations include background (from albedo, cosmic and diffuse gamma ray events) and two possible ways of signal generation: the first based on a complete physi-

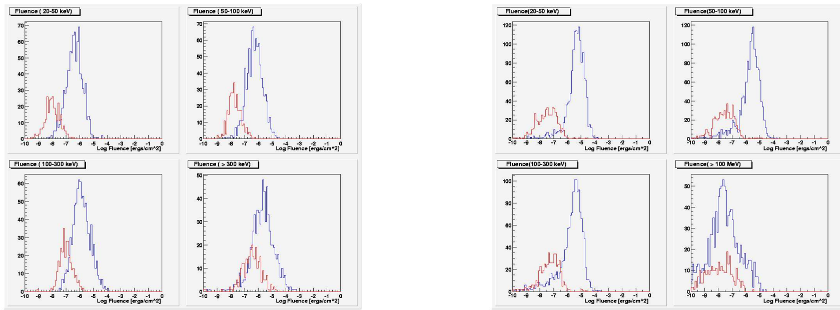

Figure 2. Comparison of fluences between the simulated catalog (right) and BATSE observation (left). The 4th plot in the right panel shows the estimated emission for short burst (red) and long burst (blue) above 100 MeV.

cal model, the second based on a phenomenological extrapolation from BATSE data. Orbit, tilting and correct exposure are also taken into account.

The physical model has been validated in the following way: the BATSE observed distribution of duration has been fitted with a double gaussian, for short and long bursts (see Figure 1, left panel). Then, we used this bimodal distribution as input parameter for our model, which explores the parameter space and returns a burst with a given duration. The resulting simulated catalog is depicted in Figure 1, right panel. Finally, the simulated fluences are compared with the observed ones, for the 4 BATSE channels (Figure 2). In this way we have a calibration method to correlate the emission at high energy with the low energy observations. Scaling laws are also reproduced.

3. Trigger and Alerts

After calibrating the model, we investigated the efficiency of GLAST in triggering and reconstructing photons coming from GRB events. In this preliminary study we have tested various efficiencies for a sample of gamma ray bursts without background. A set of GRB's with different fluences above 100 MeV has been generated, and the resulting signal has been processed through the LAT instrument simulator. Figure 3 (left) shows the number of incident, triggered and reconstructed gammas as a function of fluence above 100 MeV. The general trend is that for a typical burst of 10^{-8} erg/cm^2 we expect approximately 100 incident photons, and a photon trigger efficiency of 30%. More than 90% of the triggered photons will then be reconstructed.

For the purpose of this study, we use a 'strawman' real time unbinned trigger algorithm: the sky is scanned with a sliding 20 event window, looking for clusters of events in a 35 degree circle; then a joint spatial-temporal likelihood is formed. The threshold for this trial situation was set adopting an arbitrarily low background event rate of 3 Hz, to produce less than one false trigger per week.

The preliminary results of this trigger simulation are presented in Figure 3. For the quoted background event rate, efficiency reached about 85% for the

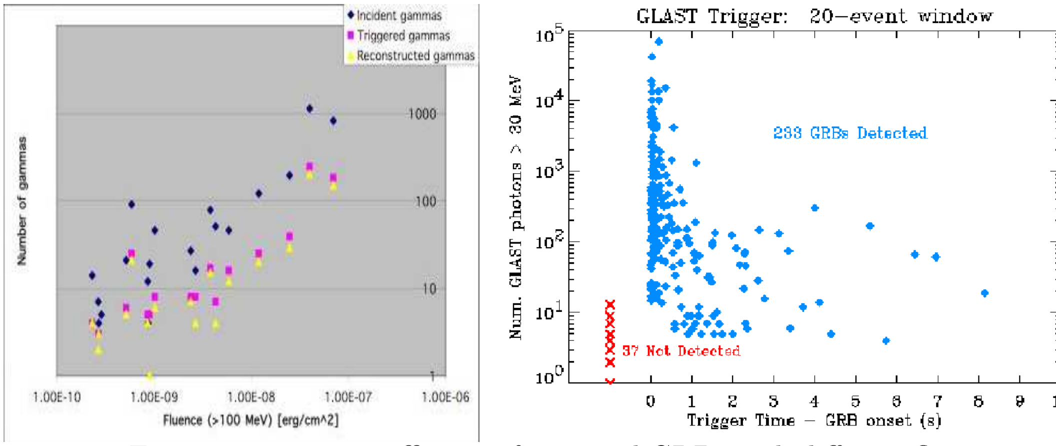

Figure 3. Trigger efficiency for several GRBs with different fluences. The number of incident, triggered and reconstructed photons are indicated.

BASTE-like bursts, with around 78% of those bursts detected by GLAST within one second of GRB onset.

4. Conclusion

We have investigated the performances of GLAST in detecting GRB events, using a complete simulation chain. From our preliminary results, it appears that GLAST should be able to substantially improve on the EGRET detection rate of about one GRB per year. In addition to burst alerts and localizations provided by the GBM, the LAT should also be able to provide real time triggers and GRB localizations.

Refinements to the trigger simulations will include simulations at higher background event rates, spatial dependence of diffuse gamma flux, and temporal dependence of the on board background rates.

Acknowledgments. J.D Scargle acknowledges support from NASA's Applied Information Systems Research Program.

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